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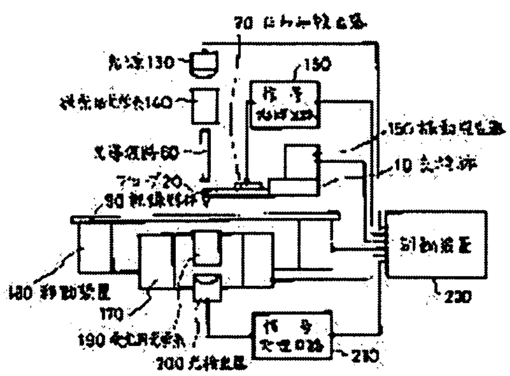
(54) OPTICAL RECORDING DEVICE

(57)Abstract:

PURPOSE: To obtain a device of which constitution and a control method are simple and integration efficiency of a probe is good by using plural probes performing optical writing or reading, in an optical recording device using optical proximity field effect.



CONSTITUTION: A probe 20 performing optical writing or reading for a recording medium 90 is held by a holder 10 at near the recording medium 90. Light from a light source 130 is transmitted to the probe 20 through an optical system 140 and an optical waveguide path 80. Next, the recording medium 90 is irradiated with the light from the probe 20. An output of an optical detector 200 is transmitted to a control device 200 of a whole system through a signal processor 210. On the other hand, a vibrator plate 150 is mounted on the holder 10, thereby, the probe 20 is vibrated with the prescribed frequency. When writing and reading are performed, of the distance between the probe 20 close and a recording plane of the recording medium 90 is brought to ≤1/10 of an optical wavelength or less in irradiation and detection of light.

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CLAIMS

[Claim(s)]
[Claim 1] The record medium which records information using the approaching space optical effectiveness, and the light source which generates the light which irradiates said record medium, The probe of the cantilever configuration which has optical opening smaller than the wavelength of the light generated from said light source at a tip, The probe of said cantilever configuration at the include angle from which the axis of the longitudinal direction does not become perpendicular to the recording surface of said record medium And the base material held so that said optical opening may turn to the direction of said recording surface, An oscillating means for it to be arranged at said base material and to vibrate the tip of said probe in the perpendicular direction to said recording surface, The distance control means for controlling the distance between said probes and said recording surfaces, The migration means for said base material and said record medium being displaced relatively two-dimensional, The optical means for **** which converges the light generated according to said light source, and is introduced into the recording surface of said record medium, Optical recording equipment characterized by having the optical means for light-receiving converged and spread in response to the light from said record medium which it is introduced and is produced by said irradiated light, and an optical detection means to detect the optical information from said record medium produced by said irradiated light in response to said spread light.
[Claim 2] Optical recording equipment according to claim 1 which forms the optical waveguide to which it has the height which carried out the configuration of a cone, and said height has said optical opening at a tip at the tip of said probe.
[Claim 3] Optical recording equipment according to claim 1 with which said probe is formed with an optical fiber, the cone form where the tip was bent by the ** type and was radicalized in it is accomplished, and said cone section has said optical opening at a tip.
[Claim 4] It is optical recording equipment according to claim 1 which is the configuration which has a deflection detection means to detect the deflection of said probe in order to detect the amplitude by vibration of the tip of said probe by said oscillating means, and controls so that said distance control means becomes a predetermined distance about the distance of said probe detected from said deflection detection means, and said recording surface.
[Claim 5] It is optical recording equipment according to claim 1 which is the configuration which said optical detection means detects the luminous intensity which penetrated said record medium, and performs distance detection of said probe and said recording surface by comparing the detection result with a predetermined value, and controls so that said distance control means becomes a predetermined distance about the distance of said said detected probe and said recording surface.
[Claim 6] Said oscillating means is optical recording equipment according to claim 1 which is the configuration which has one [at least] adjustable means of excitation voltage and an exciting frequency, controls the amplitude at the tip of said probe by controlling said adjustable means, and tunes the distance of said probe and said recording surface finely so that it may become a predetermined distance in order to change the amplitude by vibration of the tip of said probe.

[Claim 7] Optical recording equipment according to claim 1 with which formation maintenance of said probe was carried out in one in contact with the cantilever configuration a total at said base material [claim 8] Optical recording equipment according to claim 1 arranged so that formation maintenance of said two or more probes may be carried out at said one base material and each optical opening of two or more of said probes may counter coincidence at the recording surface of said record medium [claim 9] Said two or more probes are formed so that the elastic resonance frequency as a cantilever may differ, respectively. Said oscillating means By vibrating the specific probe of said two or more probes, and controlling by controlling an exciting frequency, so that said specific probe serves as said recording surface and a predetermined distance Optical recording equipment according to claim 8 said whose specific probe is the configuration of performing record and read-out of the information on said record medium.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the optical recording equipment which performs writing and read-out of data to a record medium by high density using the approaching space optical effectiveness.
[0002]
[Description of the Prior Art] writing to a record medium and read-out are performed using light as one of the techniques which carry out record playback of the data -- optical recording -- there is an approach. As a typical example of optical recording, it is changing the magnetization direction of a magnetic thin film locally, and there is the approach of carrying out record and read-out of data. By this approach, the thin film of the amorphous alloy which generally consists of a rare earth metal and transition metals as a record medium is used. Where this magnetic thin film is installed into a predetermined field, light is irradiated, and the magnetization direction of that part can be made into a different thing from the direction of magnetization of a surrounding magnetic thin film by heating the part of a magnetic thin film from that Curie point or compensation point. It means that this had recorded the data equivalent to 1 bit of a digital signal on the magnetic thin film.
[0003] In order to read the recorded bit, the plane of polarization of the transmitted light of a magnetic material or the reflected light applies the Faraday effect or the Kerr effect of a magnetic material of changing with magnetization directions. That is, the laser light which condensed with the optical lens etc. is irradiated on a magnetic thin film, change of the polarization direction of the transmitted light or the reflected light is detected, and the existence of the existence of a magnetic bit is read. However, the plane of polarization of the light irradiated at this time is beforehand arranged with the predetermined field. Moreover, the luminous energy to irradiate is a thing of extent which does not heat the part of the magnetic thin film with which light is irradiated from the Curie point or compensation point.
[0004] Moreover, data writing is performed by changing the molecular structure to specific polymeric materials by irradiating a predetermined light as an example different from magnetic record, and changing a refractive index locally as the result, and there is a method of reading data by next detecting change of a refractive index etc.
[0005] One of the having to pay one's attention in optical recording is the diameter of a spot of the light irradiated on a record medium. It is because this diameter of a spot determines the magnitude of the record bit generated by the record medium and affects recording density greatly further. Although it was common to have irradiated at a record medium what condensed laser light by the optical lens system with the conventional technique, by such approach, the limitation extracted the diameter of a spot from the diffraction limitation of light even before and after 1 micron.
[0006] On the other hand, it made the magneto-optic recording the example that magnitude of the record bit in optical recording is made to below the wavelength of light, and it was shown by by applying the approaching space optical effectiveness in recent years (E. Betzig et al., Appl.Phys.Lett.61(2), pp.142-144, 13 July 1992, JP,4-291310,A). According to this approach, after processing the end of an optical

fiber in the shape of a cone first, the coat of the metal thin film was carried out to that front face, and small opening (optical opening) is prepared in the further latest metal thin film. The magnitude of opening is smaller than the wavelength of the light to be used. By this, only by the light which has spread the inside of an optical fiber letting the opening pass, it will be irradiated by the external world.
[0007] If the tip of an optical fiber is close brought on the surface of a magnetic thin film to a distance shorter than the wavelength and light is irradiated on a magnetic-thin-film front face, a magnetic thin film will be heated locally and the part will serve as magnitude of opening, and comparable magnitude. Record of the array of the magnetic bit of 60nm of diameters is attained by irradiating Ar-ion-laser light intermittently by 120nm spacing of every direction, scanning an optical fiber in a field parallel to a recording surface in this condition. Since [which controls the location of an optical fiber by nanometer order] it will not become if it kicks, the raster scan is carried out to the scan of an optical fiber using the piezo-electric element which can realize location precision high as an actuator.
[0008] Moreover, although the recorded magnetic bit is read, scanning the tip of an optical fiber like the case of record in the condition of having brought close on the surface of the magnetic thin film, the light which arranged plane of polarization in the predetermined direction is irradiated on a magnetic thin film from an optical fiber, and it is carrying out by detecting change of the plane of polarization of the light which penetrated the magnetic thin film.
[0009] Here, when using the approaching space optical effectiveness, the distance from the magnetic-thin-film front face of an optical fiber may have to be controlled below to a value predetermined with high degree of accuracy as a very important point. A here predetermined value means the die length of the wavelength of the light to be used. The method of performing position control of an optical fiber is used by vibrating an optical fiber in an parallel field to a recording surface, and detecting change of the shearing stress which acts on an optical fiber to this. (E. Betzig et al., Appl.Phys.Lett.60 (20) pp.2484-2486, 18 May 1992; JP,6-50750,A) .
[0010] By this approach, first, an optical fiber is installed so that it may be fixed to the electrode holder which consists of the rigid body and the shaft of an optical fiber may become perpendicular to a magnetic-thin-film front face (the shaft which becomes perpendicular to a magnetic-thin-film front face is hereafter called the z-axis), and so that opening of an optical fiber may face a magnetic material front face. Thereby, the load rate of the optical fiber is small on the surface of a magnetic material in the direction of [within an parallel field (it is called xy side below)], and becomes large in the direction of the z-axis. Said some of electrode holders consist of piezo-electric elements, and it generates the vibrational motion within xy side at the tip of an optical fiber by vibrating this piezo-electric element.
[0011] The frequency of this vibrational motion is set up near [resonance frequency] an optical fiber. In this condition, when an optical-fiber tip is brought close to a magnetic material front face, shearing stress occurs among both and the amplitude R and phase theta of vibration of an optical fiber show change. It depends for the rate of this change of R and theta on distance (it is called z-axis distance below) from a magnetic material front face. Using this, the value of R and theta is detected, and the z-axis distance of an optical fiber is controlled so that the value of X further obtained by X=Rcostheta becomes fixed.
[0012]
[Problem(s) to be Solved by the Invention] As mentioned above, when using the approach of detecting shearing stress for controlling z-axis distance of an optical fiber, equipment is constituted so that vibrational motion with an optical fiber excessive in the direction of the z-axis etc. may not be caused and the load rate of the direction of the z-axis may become very large. With such a configuration, when an optical fiber contacts a record medium under the effect of the vibration from the external world, the irregularity of a recording surface, etc., all collision energies concentrate at the tip of an optical fiber, and the technical problem that an optical-fiber tip is easy to be destroyed mechanically occurs.
[0013] Moreover, in the optical recording using the approaching space optical effectiveness, in order to perform high density record, an optical fiber must be scanned with high degree of accuracy. For the reason, it is most common to carry out a raster scan, using a piezo-electric element as an actuator. However, in a practical piezo-electric element, the maximum length which can be scanned is about 100

micrometers. Furthermore, although the rate to scan is decided by oscillation frequency of a raster scan, it is at most about 10kHz in a piezo-electric element also with this practical. In performing optical recording from these things using a single optical fiber, a limitation is in the writing / read-out rate of the amount of data and data to deal with.

[0014] Then, the purpose of this invention is optical recording equipment which used the approaching space effectiveness of light, and that the tip of a probe is hard to be destroyed mechanically, even when effectual writing / read-out rate use two or more probes quickly, its control approach of the z-axis distance of each probe is simple, and is to offer optical recording equipment with the sufficient accumulation effectiveness of a probe moreover.

[0015]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, in this invention, the probe which carried out the configuration of the cantilever which has the height of a cone or a multiple drill in the part as a probe for performing optical writing or read-out to a record medium in optical recording equipment was used. However, the part or all in which a probe contains a height consists of optical waveguide. Moreover, there is optical opening of predetermined magnitude at the tip of a height, and it could be made to carry out from incidence or optical waveguide to optical waveguide outgoing radiation of the light through the optical opening. Moreover, the means for detecting the amount of deflections of a probe to some probes if needed was attached.

[0016] Next, it is the direction where the axis with which the load rate serves as max, i.e., the axis in alignment with the longitudinal direction of the probe of a cantilever configuration, does not become perpendicular to the recording surface of a record medium about a probe, for example, the direction where the axis serves as a recording surface and abbreviation parallel, and it held with the base material near the record medium so that optical opening might turn to the recording surface. Moreover, the optical waveguide of a probe was optically connected to other optical waveguides connected to the predetermined light source or the means for photodetection in this condition.

[0017] Next, by vibrating a base material, the probe was vibrated in the perpendicular direction to the recording surface, and the distance between a probe and a record medium was adjusted so that the distance between all probes and recording surfaces might become below a predetermined value intermittently. A here predetermined value is about [of the wavelength of the light used by optical writing and read-out] 1/10.

[0018] Many things are considered as a means to control the distance between a probe and a recording surface. With the 1st means, it acts as the monitor of the change of the amplitude of a probe with a means to detect the amount of deflections of a probe. The distance between a probe and a record medium is controlled by moving a base material with the migration means of a range direction so that the amplitude of a probe may become smaller than a predetermined value.

[0019] With the 2nd means, light is first irradiated from a probe at a record medium. A photodetection means detects the light which penetrated the record medium among the irradiated light, and it acts as the monitor of the reinforcement. It controls by moving a base material with the migration means of a range direction so that the detected luminous intensity may become larger than a predetermined value intermittently about the distance between a base material and a record medium. Or even if it makes it the 2nd means be the following, it is realizable. That is, light is irradiated from a locating [a probe] and opposite side on the conditions which carry out total reflection at a record medium. A probe detects the light which penetrated the record medium among the irradiated light, and it acts as the monitor of the reinforcement. It controls by moving a base material with the migration means of a range direction so that the detected luminous intensity may become larger than a predetermined value intermittently about the distance between a base material and a record medium.

[0020] After approaching within limits with the amplitude of a probe possible in which and installing a probe in a recording surface beforehand, by changing the exciting frequency and excitation voltage which are impressed to the excitation means attached in the base material of a probe, the amplitude of the vibration accompanying resonance of a probe is changed and the distance between a probe and a recording surface is intermittently controlled by the 3rd means below to a predetermined value. On the

other hand, optical writing was performed by irradiating the light of predetermined reinforcement from opening to a recording surface.

[0021] Moreover, read-out of data irradiated light from opening at the record medium, and was performed by detecting the transmitted light. Moreover, it is also possible to irradiate light from opening at a record medium, and to detect the reflected light. Furthermore, it is also possible to carry out by irradiating light from an installing [the probe]-in record medium and opposite side, and detecting the transmitted light with a probe. Here, the light which irradiates a record medium responded to **, and that by which the plane of polarization was beforehand arranged with the predetermined field was used for it.

[0022] However, the optical exposure for optical writing and the photodetection for read-out went only at the time of predetermined conditions. A probe and a recording surface are below predetermined distance, and the conditions here predetermined are the times of the amount of deflections of a probe serving as max in the direction of a record medium, when the 1st means which mentioned above the distance between a probe and a recording surface adjusts. Moreover, when the 2nd means adjusts, it is at the time when the detected optical reinforcement is larger than a predetermined value. With the 3rd means, it is a time of giving a predetermined excitation signal to the excitation means of a probe.

[0023] Furthermore, as an effective means for performing writing or read-out of information quickly, two or more probes can be put in order at the predetermined spacing, and those probes can also perform writing or read-out of information in the location where record media differ, respectively. In this case, it becomes possible to raise writing / read-out rate effectually by carrying out accumulation formation of two or more two or more probes at a base material and one, writing in each probe in coincidence juxtaposition, and using it for read-out with a probe single as mentioned above, since the field which can be scanned is comparatively small.

[0024]

[Function] In this invention, what carried out the configuration of a cantilever as a probe is used. And it holds with the base material so that the shaft with which the load rate as the cantilever becomes the largest may not become perpendicular to the recording surface of a record medium. Furthermore, the record medium is made to approach, vibrating a base material in the perpendicular direction to a recording surface.

[0025] In such a configuration, a probe has a comparatively small load rate in the perpendicular direction to a recording surface. That is, when a probe contacts a recording surface, a probe bends easily and absorbs the pressure produced in the contact surface by the deflection of the whole probe. Therefore, it becomes possible to prevent the force to the extent that it destroys mechanically concentrating a probe in the contact surface.

[0026] Moreover, since it will be possible to bend so that each probe may meet the irregularity even if irregularity is in a record medium when the distance between all the probes and recording surfaces that were attached in the base material especially when two or more probes were used makes a base material approach even to a record medium until the approaching space optical effectiveness serves as an effective distance, it is not necessary to constitute two or more devices for carrying out position control of each probe.

[0027] Furthermore, by this invention, in order to control the distance between a probe and a recording surface, the approach of detecting change of the amplitude of a probe is used. By this detection approach, the distance between a probe and a recording surface is adjusted so that it may have the amplitude smaller than the amplitude when the probe is vibrating freely. Thereby, the tip of the height of a probe comes to contact a record medium intermittently.

[0028] Moreover, the approach of acting as the monitor of the luminous intensity detected with a probe can also be used, irradiating light so that total reflection may be carried out to a record medium from an installing [the probe] and opposite side, in order to control the distance between a probe and a recording surface. By this approach, while a probe vibrates, it approaches to wavelength extent of light currently irradiated on the surface of a record medium, the EBANESSENTO light which appears on the surface of a record medium is detected, and the distance between a probe and a recording surface is

adjusted so that the optical reinforcement which is acting as the monitor as a result may have peak value higher than a predetermined value intermittently.
[0029] On the other hand, when irradiating light from a probe at a recording surface, since the EBANESSENTO light from minute opening of a probe is strongly scattered about by the case where the distance of a probe and a recording surface turns into below the distance for wavelength, the distance between a probe and a recording surface is adjusted by acting as the monitor of the luminous intensity reflected by transparency or the recording surface in the recording surface.
[0030] As mentioned above, in this invention, with the optical recording equipment which used the approaching space optical effectiveness, the control approach of the distance between the configuration and record medium, and base material was simple, and became possible [offering equipment with the high accumulation effectiveness of a probe]. Furthermore, since it becomes unnecessary [the migration equipment of a range direction] when changing the amplitude of a probe and performing distance control by changing an exciting frequency and excitation voltage, although the above distance control is attained by using the migration equipment of a range direction, the configuration of equipment is simplified. Moreover, it is possible by changing two or more die length and sizes of a probe little by little to be able to change the resonance frequency of this probe and to perform channel selection of record, read-out, etc. for probe itself. Furthermore, use of the probe with which resonance frequency differs is effective in suppressing contact to the recording surface of each probe to the minimum.
[0031]
[Example] Below, the example of this invention is explained based on drawing. Drawing 1 is the explanatory view having shown an example of the configuration of optical recording equipment. The probe 20 for performing optical writing or read-out to a record medium 90 is held near the record medium 90 by the base material 10. The light from the light source 130 spreads to a probe 20 through optical system 140 and optical waveguide 80. Next, the light is irradiated on a record medium 90 from a probe 20. The optical system 190 and the photodetector 200 for light-receiving were installed in the probe 20 and the opposite side of a record medium 90. The output of a photodetector 200 is told to the system-wide control unit 220 through the signal-processing machine 210. On the other hand, the oscillating object 150 is attached in the base material 10, and, thereby, a probe 20 vibrates on a predetermined frequency to it.
[0032] Moreover, the deflection detector 70 for detecting the deflection of a probe 20 is attached in the probe 20, and the signal from there is told to a control unit 220 through the signal-processing machine 160. A coarse adjustment and jogging have come to be able to do a record medium 90 in three dimension with migration equipment 180, and, thereby, relative migration of a probe 20 and a record medium 90 is realized.
[0033] electromagnetism -- a coil 170 is installed near the record medium 90, and controls the direction of the field around the record medium 90 at the time of carrying out optical writing. The oscillating object 150, migration equipment 180, and the field generator 170 are controlled by the control unit 220. Next, drawing 2 is the mimetic diagram of the cross section of the probe used by this invention. The probe 20 which is carrying out the configuration of a cantilever has jutted out from the base material 10, and a part of the tip forms the height 30 which carried out the configuration of a cone or a multiple drill. However, even if the tip of a height 30 is an acute angle, as shown in drawing, it may be the projection with the flat projection summit. Optical waveguide 50 is formed in the interior of a height 30, and it has two optical openings 60 and 120. However, the magnitude of the optical opening 60 is smaller than the wavelength of the light used by this invention. The probe 20 was manufactured by etching silicon and was obtained by forming glass in optical waveguide 50 with a sol gel process.
[0034] It is ****** with picking about an electric resistance component as a deflection detector 70 for detecting the deflection of a probe to some probes. Since the deflection detector 70 is also expanded and contracted when a probe bends, it becomes possible to detect the amount of deflections of a probe by acting as the monitor of the change of resistance of the electric resistance component produced as a result. In addition, it is also possible to use a piezo-electric element or an electrostatic-capacity sensor instead of an electric resistance component.

[0035] Moreover, it considered as the configuration which attaches a probe 20 two or more picking as shown in a base material 10 at drawing 3 . Thus, it made it possible to perform the writing and read-out of data to a record medium at a high speed in juxtaposition by using two or more probes for coincidence. Drawing 4 is the explanatory view showing the probe 20 in this invention, the optical waveguide 80 for spreading the light to a probe, or the light from a probe, and physical relationship with a record medium 90. The probe 20 is installed at the include angle from which the axis 100 with which the load rate becomes the largest, i.e., the axis in alignment with the longitudinal direction of a probe 20, does not become perpendicular to the recording surface 110 of a record medium 90, and the horizontally near desirable include angle. At this time, the optical opening 60 of a probe 20 has turned to the recording surface 110. Moreover, it installed near the optical opening 120 so that the optical waveguides 80, such as optical FIABA, might be optically connected with the optical waveguide 50 of a probe, for example.
[0036] Drawing 10 is the explanatory view of other examples of the probe 20 in this invention. What extended until the heating unit was separated in the center, while the probe 240 heated the optical fiber in drawing 10 , or processed the tip into the cone form by etching is further bent to a ** type. Coating 250 of the quality of the material which light, such as aluminum, titanium, platinum, AlSi, chromium, or gold, does not penetrate is carried out to some side faces of the optical fiber containing the cone section at a tip, and the optical opening 260 of a predetermined dimension is formed in them at the top-most vertices of a cone form. Thereby, it can be made not to carry out to an optical fiber incidence of the light from the side face of optical fibers other than optical opening 260. Here, a predetermined dimension is a dimension smaller than the wavelength of the light used for optical writing or read-out in this invention. In addition, also in a probe 240, the tip of a height may be a height with the flat projection summit, as an acute angle also shows to drawing.
[0037] As shown in drawing 10 , a probe 240 is held near the record medium 90 by the above-mentioned base material 10 and the base material 270 which achieves the same function substantially. At this time, the axis 280 with which the load rate of a probe 240 serves as max is arranged so that it may not become perpendicular to a recording surface 110, namely, so that the include angle a in drawing 10 R> 0 may not turn into 0 times. An include angle a is preferably set as 45 - 85 degrees. Moreover, it is made for the corner of a street at the tip of a probe 240 to become equal to an include angle a. In addition, in the configuration shown in drawing 10 , a probe 240 achieves to coincidence the function of the optical waveguide 80 and the probe 20 which were shown by drawing 3 .
[0038] Moreover, a means 70 to bend if needed and to detect an amount is attached in some probes 240 (not shown). Furthermore, it is [in / about making two or more probes hold to one base material, as the writing and read-out of data by this invention are shown in drawing 3 for the purpose of carrying out to a high speed / a probe 240] possible similarly.
[0039] Next, the configuration of the optical system in this invention is explained. Drawing 5 is the explanatory view showing one example of the configuration of the optical system in this invention. The light generated in the light source 130 spreads to optical waveguide 50 through the optical system 140 for ****, optical waveguide 80, and the optical opening 120, and is irradiated by the record medium 90 from the optical opening 60. After the irradiated light penetrates a record medium 90, it is detected by the optical system 190 for light-receiving and the photodetector 200 which were installed in facing the probe 20 of a record medium 90, and the opposite side.
[0040] Drawing 6 is the explanatory view showing another example of the propagation path of light. The light generated in the light source 130 arranged under the record medium 90 irradiates light through the optical system 140 for **** on the inferior surface of tongue of a record medium 90. The light which penetrated the record medium 90 invades into the optical waveguide 50 of a probe 20 from the optical opening 60, is further spread to optical waveguide 80 and the optical system 190 for light-receiving, and is detected by the photodetector 200.
[0041] Drawing 7 is the explanatory view showing still more nearly another example of the propagation path of light. On the inferior surface of tongue of the record medium 90 by the side of that the probe 20 is installed, and opposite, the light generated in the light source 130 is irradiated through the optical system 140 for **** so that light may carry out total reflection. EBANESSENTO light appears in the

front face of the side which has, as a result, installed the probe 20 of a record medium 90. A part of EBANESSENTO light invades into the optical waveguide 50 of a probe 20 from the optical opening 60, it is further spread to optical waveguide 80 and the optical system 190 for light-receiving, and is detected by the photodetector 200.

[0042] Since the approaching space effectiveness of light is used in this invention, when irradiating light from a probe 20 to a recording surface 110, or when a probe 20 detects the light from a recording surface 110, it is necessary to control the optical opening 60 of a probe, and the distance of a recording surface 110 to become smaller than the wavelength of light. Below, the distance control approach is explained.

[0043] Drawing 8 is the explanatory view showing typically the situation of change of the amplitude of the probe 20 when changing the distance between a probe 20 and a recording surface 110. This amplitude maintains constant value A, when the height tip 40 of a probe does not touch a recording surface 110, but if it comes to contact, it has the decreasing [the amplitude]-with reduction in distance **** features. Therefore, if it detects that the amplitude is smaller than a value A, and the height tip 40 of a probe touches the recording surface 110 intermittently, it can distinguish. Here, it can be distinguished by detecting the maximum value change of the amount of deflections of a probe 20 whether the amplitude is smaller than a value A. Detection of this amount of deflections can be performed by attaching an electric resistance component, a piezo-electric element, or an electrostatic-capacity sensor in a probe 20, as the term of explanation of drawing 2 described.

[0044] The base material 10 of a probe is vibrated in the perpendicular direction to the recording surface 110 of a record medium, and it was made for the probe 20 which carried out the configuration of a cantilever as a result to vibrate near [the] the resonance frequency first as the approach of distance control. Next, the distance between a record medium 90 and a base material 10 was controlled so that the amplitude of a probe 20 became smaller than a value A. As shown in drawing 3 , when two or more probes were attached in the base material 10, the distance between a record medium 90 and a base material 10 was controlled by migration equipment 180 so that the amplitude of all probes became smaller than a value A.

[0045] Since it does not have the load rate with a big probe 20 to the direction perpendicular to a recording surface 110 when this distance control approach was used and the height tip 40 of a probe contacts a recording surface 110, a probe 20 bends and it can prevent destroying the height tip 40 or probe 20 self. Since this bends so that each probe may meet the irregularity even if irregularity is in a record medium as the term of explanation of drawing 3 described when using two or more probes for coincidence for example, it means that there is no need of establishing two or more controlling mechanisms for controlling the location of each probe independently, respectively. Consequently, it becomes possible to constitute optical recording equipment only from a single device which controls appropriately the distance between a base material common to all probes, and a record medium.

[0046] Next, how to control the distance between the base material 10 in a configuration of having the propagation path of the light shown in drawing 7 and a record medium 90 is explained. A probe 20 is vibrated near [that] the resonance frequency by vibrating a base material 10 first also in this case. Moreover, light is irradiated to a record medium 90 according to the light source 130 and the optical system 140 for ****. If distance between a base material 10 and a recording surface 110 is made sufficiently small in this condition, the luminous intensity detected with a probe 20 will change, as shown in drawing 9 with time amount. A probe 20 depends a periodic peak as shown in drawing 9 on having detected the EBANESSENTO light which exists in the front face of a recording surface 110. Then, it is possible to control appropriately the distance between a base material 10 and a record medium 90 by acting as the monitor of whether the peak value of the optical reinforcement detected is larger than the predetermined value B.

[0047] Moreover, also in the configuration which has the propagation path of the light shown in drawing 5 or drawing 6 , the detected luminous intensity shows change as shown in drawing 9 with time amount. It is possible to control appropriately the distance between a base material 10 and a record medium 90 by acting as the monitor of whether the peak value of optical reinforcement is larger than the suitable

value in each case also in these cases. Migration equipment 180 can be made to attain the above distance control.

[0048] In addition, it is possible by changing an exciting frequency and excitation voltage to change the amplitude of a probe and to perform distance control. As shown in drawing 11 , the amplitude of vibration of the probe to this exciting frequency serves as max in the resonance frequency Fs as a cantilever of a probe, and hardly vibrates in the frequency F1 shifted more slightly than this or F2. Moreover, in proportion to excitation voltage, the amplitude changes mostly by changing excitation voltage. Therefore, distance control is possible by setting up an exciting frequency and excitation voltage appropriately. When an optical-fiber probe with a diameter [of 125 micrometers] and a die length of 3mm was used, the amplitude of 0.5 micrometers was able to be obtained at the height tip of a probe by setting an exciting frequency to 20kHz near resonance frequency, and giving excitation voltage to the piezo-electric element for excitation with the amplitude of 5V.

[0049] About this distance information, although it is detectable with the means which acts as the monitor of the optical reinforcement mentioned above, since this oscillation characteristic can be determined beforehand, it always is not necessary to act as a monitor. Although a means to move the whole base material to a range direction becomes unnecessary in this case since the height tip of a probe and the distance of a recording surface can be finely tuned by controlling excitation voltage, migration equipment is also applicable to shunting of a probe etc.

[0050] Furthermore, in case two or more probes are used for coincidence, the resonance frequency of each probe can be changed little by little like drawing 12 by changing each die length and size of a probe every only. In this case, it is possible to choose the probe corresponding to channels, such as record and read-out, only by changing an exciting frequency. Furthermore, since the probe which is not chosen in this case hardly vibrates, contact to the height tip of each probe and a recording surface can be suppressed to the minimum.

[0051] Next, the writing of the data using the optical recording equipment of this invention is explained. In this case, the configuration of the optical system shown in drawing 5 was used. As a record medium 90, although the multilayers of Co/Pt were used, if it is the magnetic thin film used for a magneto-optic recording, using similarly is possible. Moreover, although semiconductor laser with a wavelength of 670nm was used as the light source, if it is the light source which can also use this for a general magneto-optic recording, it can use similarly.

[0052] the optical recording equipment shown in drawing 1 -- setting -- writing -- electromagnetism -- it is in the condition which added the uniform field to the record medium 90 with the coil 170, and carried out from the probe 20 by irradiating light to the recording surface 110. However, the exposure of light is performed, when the probe 20 is in contact with the recording surface 110 or it is close from 1/10 wave of light from the recording surface 110. When the amount of deflections of a probe serves as max in the direction of a recording surface 110, specifically, it is a time of the transmitted light reinforcement of a record medium 90 serving as max. Thereby, light was able to be irradiated to the partial field of magnitude comparable as the optical opening 60.

[0053] Luminous energy to irradiate was made into sufficient amount to heat the magnetic substance which constitutes a record medium 90 more than the Curie point. Consequently, the record medium was able to be made to have been able to heat locally and the magnetization direction of the heating unit was able to be changed. Thus, the method of changing the magnetization direction of a record medium locally with heating is an approach generally used by the magneto-optic recording. in addition -- this example -- electromagnetism -- it was able to write in also in the condition that there is no uniform magnetic field with a coil 170.

[0054] When reading the written-in data, it is also possible to use the configuration of drawing 5 R> 5 and which optical system of 6 and 7. In this case, the light which arranged that plane of polarization with the record medium 90 beforehand is irradiated, and the direction of the plane of polarization of the light which penetrated the record medium 90 is performed by detecting with optical system 190 and a photodetector 200. It is the same as the approach of also using this approach by the general magneto-optic recording. However, in this example, detection of the direction of plane of polarization was

restricted to the time when the probe 20 is in contact with the recording surface 110, or it is close from 1/10 wave of light from the recording surface 110, and was performed.
[0055] Moreover, as a record medium 90, it is also possible to use thin films, such as SbTe besides the above-mentioned thing, TeSe, or GeSbTe. In this case, it sets in writing, and by optical exposure, it heats and phase transition of the record medium is carried out. in addition, electromagnetism -- a coil 170 is not used in this case. Since, as for the part which carried out phase transition, the light transmission nature changes, read-out is performed by detecting change of the transmitted light reinforcement.
[0056] In the case of these read-out and writing, a scan is horizontally performed by the migration device 180 two-dimensional. In the case of this example, the precision of this scan is required for at least 0.005 micrometers, and the scanning range is about 400 micrometers of every direction. In this case, when the recording density of 100 megabits per one probe is obtained and 16 probes are constituted using a 0.04-micrometer record bit, 1.6-gigabit record can be constituted to the field of 2 1cm on the whole.
[0057] Introducing is possible by condensing the light generated from the light source to the optical opening 120 of a direct probe, without using the optical waveguide 80 in drawing 1 besides the example described above about optical system. When using two or more probes, it can respond by scanning the beam of light from the light source so that it may pass along the optical opening 120 of each probe.
[0058] Moreover, as shown in drawing 13 , light can be introduced from the waveguide edge on a base material 10 by extending and forming optical waveguide 50 to the cantilever section of a probe 20. This method can introduce light by one place by branching optical waveguide 300 and connecting to each of two or more probes 20 by which accumulation formation was carried out, into a base material 10, as shown in drawing 14 . Under the present circumstances, a signal can also be chosen by forming an optical switch 290 between the optical waveguide 50 of each probe 20, and the branched optical waveguide 300.
[0059]
[Effect of the Invention] As mentioned above, installing the probe of a cantilever configuration in the optical recording using the approaching space optical effectiveness in the include angle from which the axis of the longitudinal direction does not become perpendicular to the recording surface of a record medium, i.e., the include angle used as abbreviation parallel, and vibrating the height tip perpendicularly according to this invention, by performing distance control with a recording surface, there is no fear of breakage of a probe and the optical recording equipment in which minute distance control is possible can be offered.
[0060] Moreover, by performing radicalization processing at the tip of the optical fiber usually used in the probe, and bending and forming in a hook type, the probe which has minute optical opening can be obtained cheaply, and the whole equipment can be made cheap. Moreover, since it can integrate efficiently using the usual silicon processing technique etc. by forming a probe in a base material and one at two or more coincidence, the optical recording equipment of many channels can be obtained easily.
[0061] Furthermore, by forming the elastic resonance frequency of the probe of these plurality so that it may differ, respectively, and controlling the exciting frequency of the tremulor suitably, it becomes possible to operate a specific probe alternatively, and the positional controller according to individual for each probe can offer unnecessary optical recording equipment.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the explanatory view showing the outline of the configuration of the optical recording equipment of this invention.
[Drawing 2] It is the explanatory view showing typically the cross section of the probe used by this invention.
[Drawing 3] It is the explanatory view showing the condition of having attached in or more two base material the probe used by this invention.
[Drawing 4] It is the explanatory view showing the physical relationship of the probe in this invention, a record medium, and optical waveguide.
[Drawing 5] It is the explanatory view showing an example of the configuration of optical system, and the propagation path of light in this invention.
[Drawing 6] It is the explanatory view showing an example of the configuration of optical system, and the propagation path of light in this invention.
[Drawing 7] It is the explanatory view showing an example of the configuration of optical system, and the propagation path of light in this invention.
[Drawing 8] In this invention, it is the explanatory view showing typically the situation of change of the amplitude of the probe when changing the distance between a probe and a recording surface.
[Drawing 9] In this invention, it is the explanatory view showing typically the situation of time amount change of the optical reinforcement detected with a probe.
[Drawing 10] It is the explanatory view showing other examples of the probe used by this invention.
[Drawing 11] It is the explanatory view showing typically change by the exciting frequency and excitation voltage of the amplitude of vibration of a probe in this invention.
[Drawing 12] It is the explanatory view which can be set to this invention and in which showing typically the property of an amplitude over the exciting frequency of the probe with which two or more resonance frequency differs.
[Drawing 13] It is the explanatory view showing typically the cross section of the probe in which the optical waveguide in this invention was formed on the front face.
[Drawing 14] It is the explanatory view showing typically the condition of having attached two or more picking about the probe in which optical waveguide was formed on the front face used by this invention.

[Description of Notations]
10 Base Material
20 Probe
30 Height
40 Height Tip
50 Optical Waveguide
60 Optical Opening
70 Deflection Detector

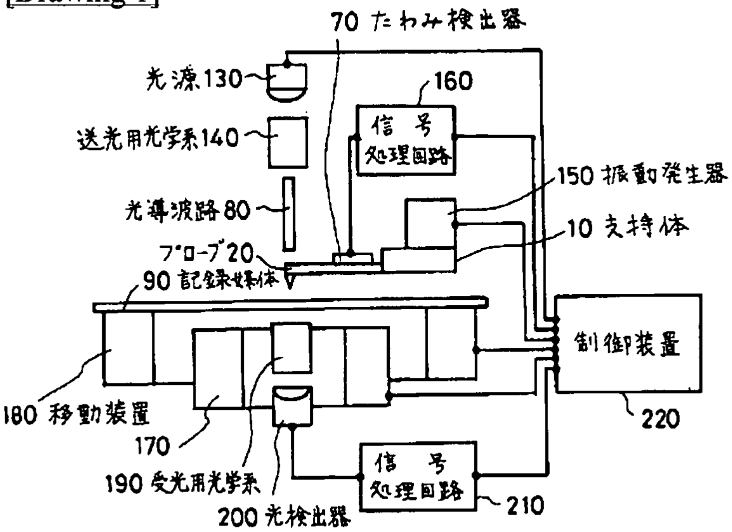
80 Optical Waveguide
90 Record Medium
100 Axis with which Load Rate Serves as Max
110 Recording Surface
120 Optical Opening
130 Light Source
140 Optical System for Light Transmission
150 Tremulor
160 Signal-Processing Machine
170 Field Generator
180 Migration Equipment
190 Optical System for Light-receiving
200 Photodetector
210 Signal-Processing Machine
220 Control Unit
230 Half Mirror
240 Probe
250 Coating
260 Optical Opening
270 Base Material
280 Axis with which Load Rate Serves as Max
290 Optical Switch
300 Optical Waveguide

[Translation done.]

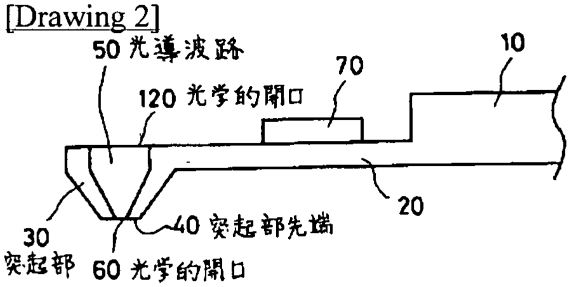
* NOTICES *

DRAWINGS

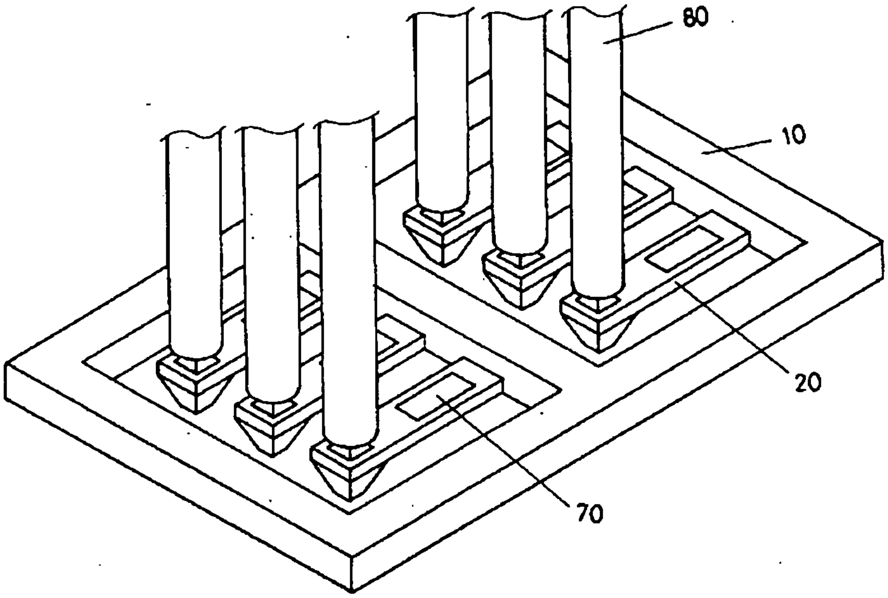
[Drawing 1]



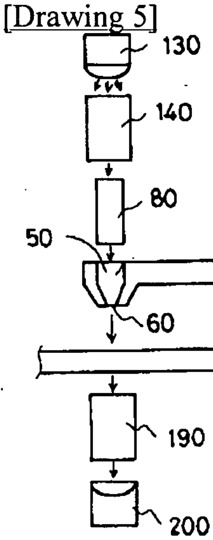
[Drawing 2]



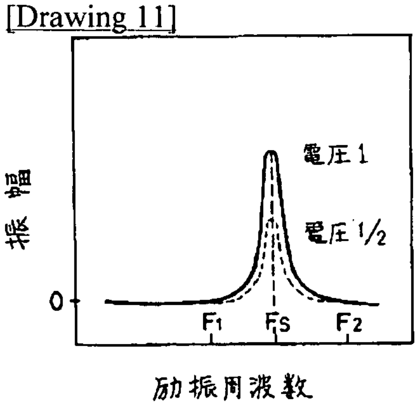
[Drawing 3]



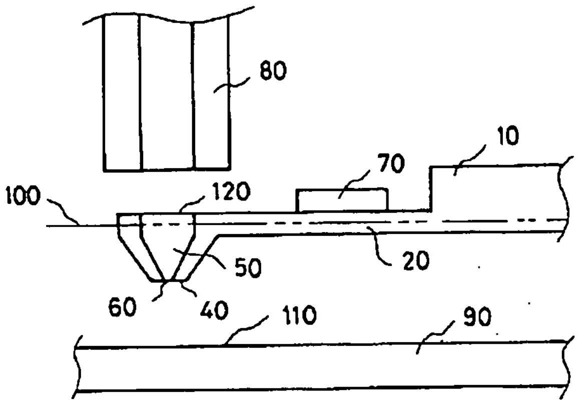
[Drawing 5]



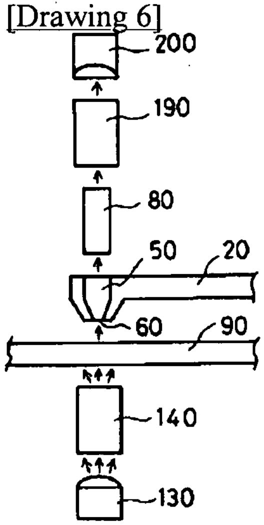
[Drawing 11]



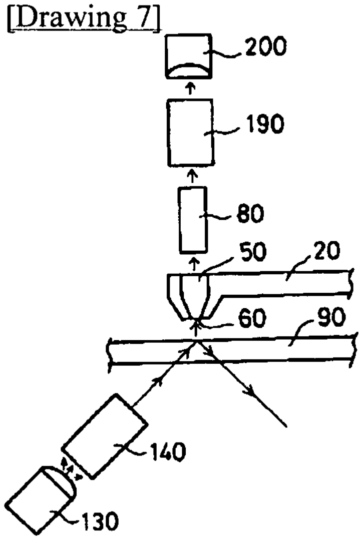
[Drawing 4]



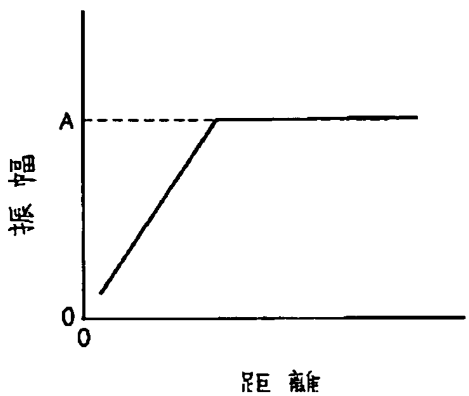
[Drawing 6]



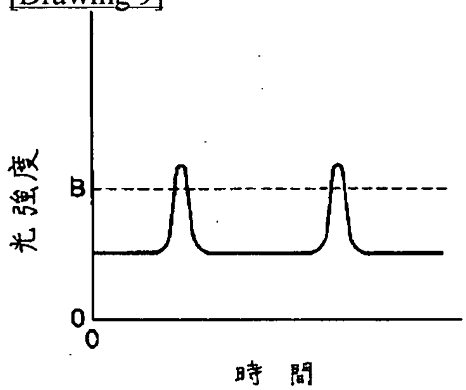
[Drawing 7]



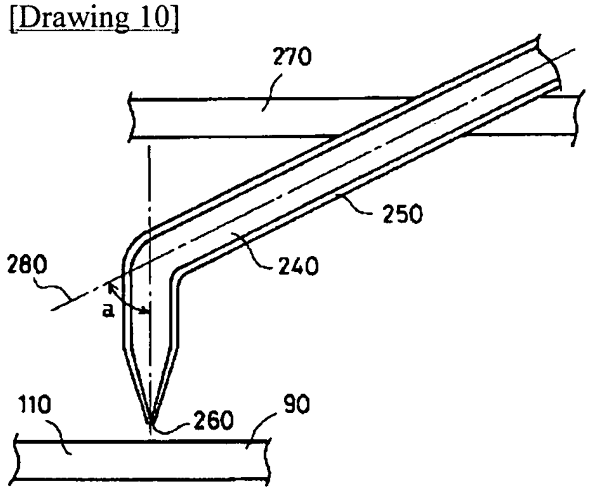
[Drawing 8]



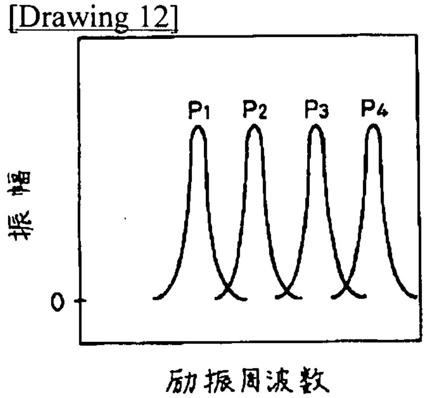
[Drawing 9]



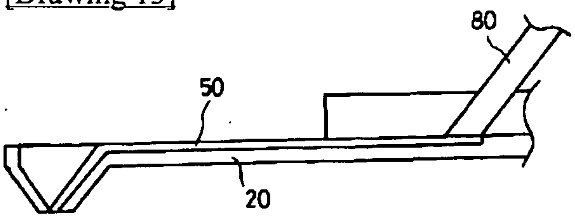
[Drawing 10]



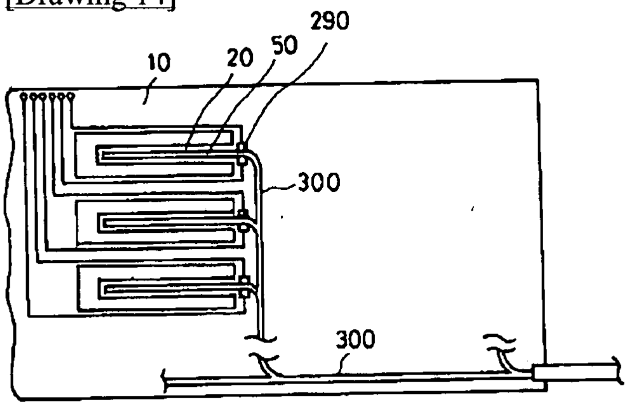
[Drawing 12]



[Drawing 13]



[Drawing 14]



[Translation done.]